Year 3 Report 6, 10/20/08-12/19/08

NNSO6AA78G, "Improving water resources management in the western U.S. through use of remote sensing data and seasonal climate forecasts"

Dennis P. Lettenmaier
Department of Civil and Environmental Engineering
University of Washington

Project Officer:
Gregory Fletcher
NASA Stennis Space Center
(Gregory.Fletcher@ssc.nasa.gov)

This is a joint project of the University of Washington and the University of California, Irvine (PI S. Sorooshian). It is aimed at utilizing NASA remote sensing data and hydrologic and climate prediction models in a partnership with three operational water management agencies – the Natural Resources Conservation Service, which provides seasonal streamflow forecasts over most of the west, the U.S. Bureau of Reclamation, which has decision authority within the Klamath River basin (where there have been ongoing and highly publicized conflicts over water allocation), and the California Department of Water Resources, which has decision authority for much of the Sacramento River basin. The project leverages heavily from the University of Washington's west-wide hydrologic forecast system (http://www.hydro.washington.edu/forecast/westwide). While the primary focus of this research is on water management, there are secondary benefits for the energy sector, particularly hydropower. This report covers work conducted the University of Washington, and by U.C. Irvine (under contract to UW)

The project consists of seven tasks as follows:

Task 1: Klamath River forecast system enhancements

The existing UW west-wide forecast system will be enhanced for application in the Klamath R. basin. In particular, we will add forecasts points of interest to USBR, and will apply MODIS SCA updating that we have previously tested in the Snake River basin. We will modify the current UW forecast system to a 1/16 degree grid resolution (currently 1/8 degree), to capture smaller drainage areas within the Upper Klamath River area. We will migrate the forecast system so that it can be run at NWCC, with performance monitored by both the UW team as well as USBR Klamath Basin Area Office operational staff.

Status: SNOTEL and California Cooperative Snow Surveys (CCSS) ground observations were compared with satellite/modeled snow data derived from four sources – MODIS SCA, MODIS SCA 8-day composites, Blended SSM/I SWE (Global EASE-Grid 8-day Blended SSM/I and MODIS Snow Cover), and VIC model output. As shown in Figure 1, VIC model, MODIS SCA 8-day composite, and Blended SSM/I SWE data show good agreement with ground observations at elevation bands above 1500 m. The agree fraction is defined as the percentage of days when both satellite/modeled data and ground observations are available in which the two sets of data agree. At elevation bands below 1500 m, satellite/modeled data showed lesser agreement with ground observations, demonstrating greater complications in lower areas. As shown in Figure 2,

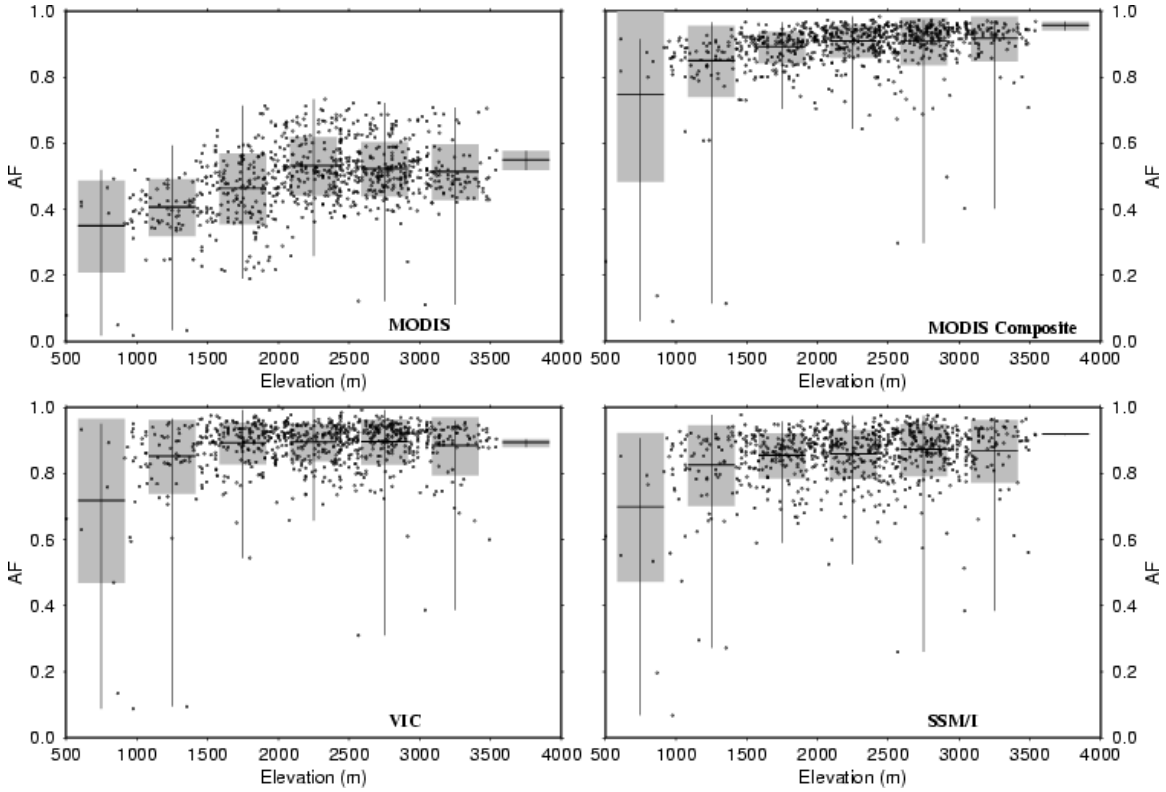

Figure 1: Agree fraction (by elevation) of SNOTEL snow observations with MODIS SCA data (upper left), MODIS SCA 8-day composite data (upper right), VIC SCA data (lower left), and Blended SSM/I SWE data (lower right).

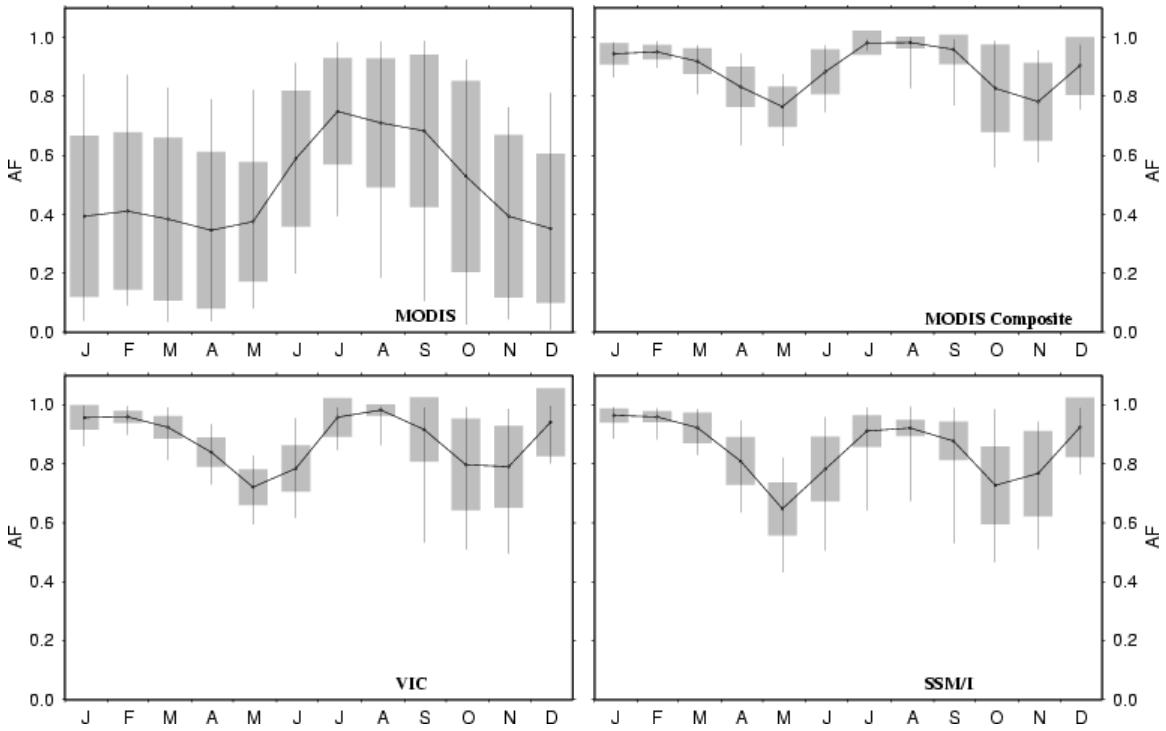

Figure 2: Agree fraction (by month) of SNOTEL snow observations with MODIS SCA data (upper left), MODIS SCA 8-day composite data (upper right), VIC SCA data (lower left), and Blended SSM/I SWE data (lower right).

VIC model, MODIS SCA 8-day composite, and Blended SSM/I SWE data show good agreement with ground observations in winter and summer, but lesser agreement in autumn and spring, particularly during the month of May. UW is working to improve the snow data assimilation system, targeting the challenge issues of lower elevations and spring months.

Task 2: Upper Klamath Lake net inflow calculation via remote sensing.

We will interact with USBR and NWCC to develop post-processed forecasts from our west-wide system that will represent Upper Klamath Lake net inflow (i.e., impairment to reflect the effects of crop water use, reservoir evaporation and ungaged local runoff). The primary alternatives to be explored include: a) a statistical temperature index method, and b) satellite-derived estimates of crop water use and of lake surface temperature, coupled with a VIC-based lake simulation. The two satellite products will be assimilated into the VIC nowcasts during the spin-up period to each forecast date. The results will be evaluated indirectly via comparison with derived UKL net inflows.

Status: An oral presentation describing the application of the MODIS-based ET estimation system to the water balance of Upper Klamath Lake was presented at AGU's 2008 Fall Meeting in San Francisco.

Task 3: Forecast system implementation/monitoring for Feather/Sac River basins

Implementation of the UW west-wide forecast system for the Sacramento basin will begin with the Feather R. before expanding to other basins in the Sacramento basin. UCI/UW team members will implement additional forecast points used by DWR, and increase the forecast system spatial resolution (i.e., to a finer grid scale) if necessary. During the first two seasons of the project, the forecasts will run in real-time (parallel to DWR operations) at UCI. Subsequently, modifications in the system required for transition to the DWR environment will be made, and data assimilation algorithms similar to those planned for the Klamath (Task 1) will be implemented.

Status: Both nowcast and forecast systems continue to run operationally at UCI's CHRS.

Task 4: Forecast impairment in CADWR/SWP basins

This task is similar to Task 2. UCI will establish, in consultation with DWR, an arrangement by which forecasted streamflows will be routed through the same decision process currently used by DWR for its operational forecasts. Either DWR will route the forecasts in parallel with their operational ones, or UCI will obtain the necessary algorithms to do so at UCI. UCI will also develop analogous methods applying to forecast system products that are new to DWR.

Status: UCI's CHRS has continued to provide DWR with technical assistance in working with the VIC model.

Task 5: Forecast communication (Klamath and Sacramento basins)

To facilitate NWCC, USBR, and DWR review of forecast system performance, UW/UCI project team members will prepare summary or explanatory reports for (a) regular, real-time forecast updates, and (b) any upgrades or major changes to the experimental forecasting system, and will host conference calls to interpret the results during the course of the forecast season (probably weekly during the period March 1 – June 1, and less frequently at other times). These conference calls and associated reports will be made available via the web. In addition, during the off-season, UW and UCI will

host one-day workshops at USBR's Klamath Falls office, and DWR's Sacramento office, to evaluate forecast system performance, and the means by which forecasts were used in the decision process in the previous season.

Status: A poster describing the application of MODIS SCA data to DWR's regression-based water supply forecasts was presented at AGU's 2008 Fall Meeting in San Francisco (Figure 3).

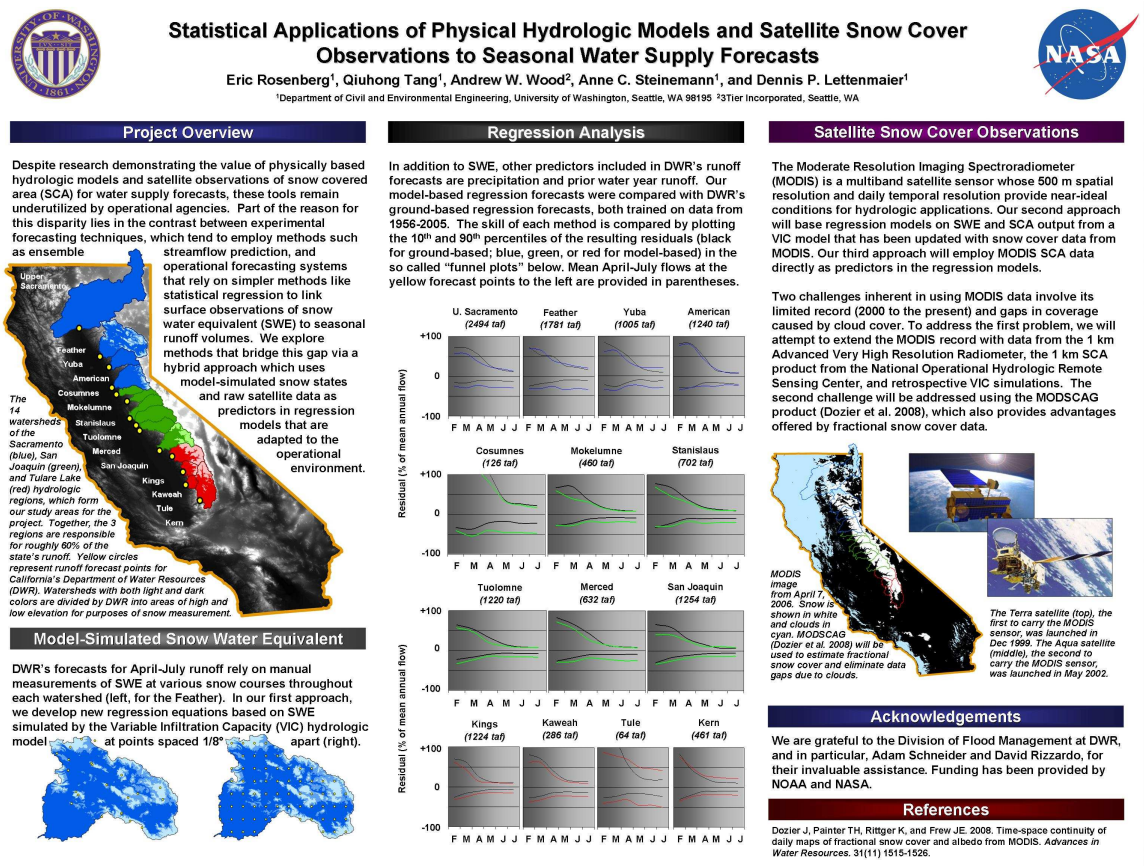

Figure 3: Poster presented at AGU's 2008 Fall Meeting in San Francisco.

Task 6: Retrospective assessment (Klamath and Sacramento)

We will undertake a retrospective assessment of forecast system performance in both study areas to serve as the basis for evaluation and modification of the forecast system. To the extent possible given the limited period of record of remote sensing data sources such as MODIS, we will perform retrospective forecasts made in a manner consistent with real-time operation, and evaluate changes in forecast skill due to incorporation of remote sensing data, and ensemble climate forecasts. We will present results of the retrospective evaluation at one or more of the planned one-day workshops (Task 5).

Status: Work on the retrospective assessment of the ET estimation system has continued.

Task 7: Transition to operations

In Year 3, before the final forecasting season, UW/UCI research team members will meet with NWCC, USCR, and DWR operational staff to plan permanent migration of those forecast elements that have performed the best into operations. As the final

forecast season progresses, the UW/UCI team members will train operational staff and prepare documentation manuals that will enable NWCC and DWR to operate the forecast system independently. Team members will make frequent trips to Portland and Sacramento during that period to troubleshoot and address any complications stemming from migrating the forecast system from the research center to the operational center, until the conclusion of the project.
Status: Work has not yet commenced on this task.